

CHAPTER 3

RELIABILITY and AVAILABILITY

3-1. Reliability

Reliability determines the probability that a system will fail under specified use and environmental conditions. It is quantified by using time to failure metrics such as failure rate and mean time between failures (MTBF). Equation 1 is commonly used to calculate reliability.

$$\text{Reliability (for time interval } t), R(t) = e^{-\lambda t} \quad (\text{Equation 1})$$

a. Failure rate describes the number of failures that have occurred during a specified time interval and MTBF describes the average time a unit will operate before failing. Both are calculated with the unit in the manufacturer's specified environment. Both of these quantities are statistical metrics that are dependent on the failure distribution of the unit. Most manufacturers provide MTBF or failure rate for their products.

b. There exists several metrics by which commercial utilities measure reliability. These metrics all measure the average availability of power to the distribution system and the utility's customer. Although these metrics are used for evaluating a utility's system, they are not used for basic reliability modeling of non-utility systems and components. Utility metrics are customized specifically for utilities. The more common of these metrics are:

- (1) System average interruption frequency index (SAIFI)
- (2) System average interruption duration index (SAIDI)
- (3) Customer average interruption duration index (CAIDI)
- (4) Average service availability index (ASAI)

3-2. Availability

Reliability and availability are often confused as being the same metric. They are related but are not the same quantity. Availability is the ability of a product or service to be ready for use when the customer wants to use it. There are several definitions of availability. Commonly used availability equations are:

$$\text{Inherent availability, } (A_i) = \text{MTBF}/(\text{MTBF} + \text{MTTR}) \quad (\text{Equation 2})$$

$$\text{Operational availability, } (A_o) = \text{MTBM}/(\text{MTBM} + \text{MDT}) \quad (\text{Equation 3})$$

Where:

MTBF is mean time between failures

MTTR is mean time to repair

MTBM is mean time between maintenance

MDT is mean down time

a. *Inherent availability* is the instantaneous probability that a component will be up. Inherent availability considers only downtime for repair due to failures. Preventative maintenance and logistics time are *not* included.

b. *Operational availability* is the instantaneous probability that a component will be up but differs from inherent availability in that it includes *all* downtime. Included is downtime for both corrective maintenance and preventative maintenance, including any logistics delay time